P-2.10 Explain the relationships among speed, velocity, acceleration, and force in rotational systems

Revised Taxonomy Level 2.7 B Explain conceptual knowledge
Key concepts
Angular displacement
Angular velocity
Angular acceleration
Angular momentum

Physical science students did not study rotational systems

As Physics for the Technology classes and traditional college prep classes will have different curricula based on the choices that are made for standards six through ten, the scope of the core curriculum should vary as well. The emphasis of topics within the core standards will depend on subsequent topics to be addressed.

It is essential for students to

- Understand that rotational motion is the motion of an object about an internal axis
- Angular displacement (θ) can be measured in units of revolutions
- Angular velocity (ω) can be measured in units of revolutions per second
- Angular acceleration (α) can be measured in units of revolutions per second-square
- Rotational inertia (I) is the resistance of a rotating object to changes in its angular velocity
  - Another name for rotational inertia is "moment of inertia"
  - The formula for the rotational inertia of an object varies with its shape but in all cases, rotational inertia is directly proportional to the mass of the object and to its diameter (or length).
- Newton's Second Law of Motion in terms of rotary motion states that when an unbalanced torque is applied to an object the object will experience angular acceleration.
  - The rate of the angular acceleration is directly proportional to the torque
  - The rate of the angular acceleration is inversely proportional to the rotational inertia of the object.
  - As such, the smaller the diameter (or length) of an object, the greater the angular acceleration a given torque will produce. (Reference ice-skater spins)

- The equations for linear motion can be applied to rotational systems

	Linear Motion	Rotary Motion
Constant velocity	$v = d/t$	$\omega = \theta/t$
Average velocity (regardless of type of motion)	$v_{ave} = \Delta d/\Delta t$	$\omega_{ave} = \Delta \theta /\Delta t$
Constant acceleration	$a = (v_f - v_i)/t$	$\alpha = (\omega_f - \omega_i)/t$
	$d = (v_{ave})\, t$	$\theta = (\omega_{ave})\, t$
	$v_{ave} = (v_i + v_f)/2$	$\omega_{ave} = (\omega_i + \omega_f)/2$
Newton's Second Law	$F = ma$	$T = I \alpha$

- Solve problems involving torque, angular inertia, angular displacement, angular velocity, and angular acceleration.

Assessment

As the verb for this indicator is explain the major focus of assessment will be for students to "construct a cause and effect model". In this case, assessments will ensure that students can model how the motion in linear systems is similar to motion in rotational systems.
Because the indicator is written as conceptual knowledge, assessments should require that students understand the "interrelationships among the basic elements within a larger structure that enable them to function together." In this case, assessments must show that students can construct a cause and effect statement relating the laws of motion to rotational systems.